Weapon Propulsion and Architecture

Naval Weapons Systems

Introduction

- Every weapon requires some form of propulsion to deliver it to its intended target.
- Propulsion systems are based on Newton's Third Law: To every action there is an equal and opposite reaction.

Types of Propulsion

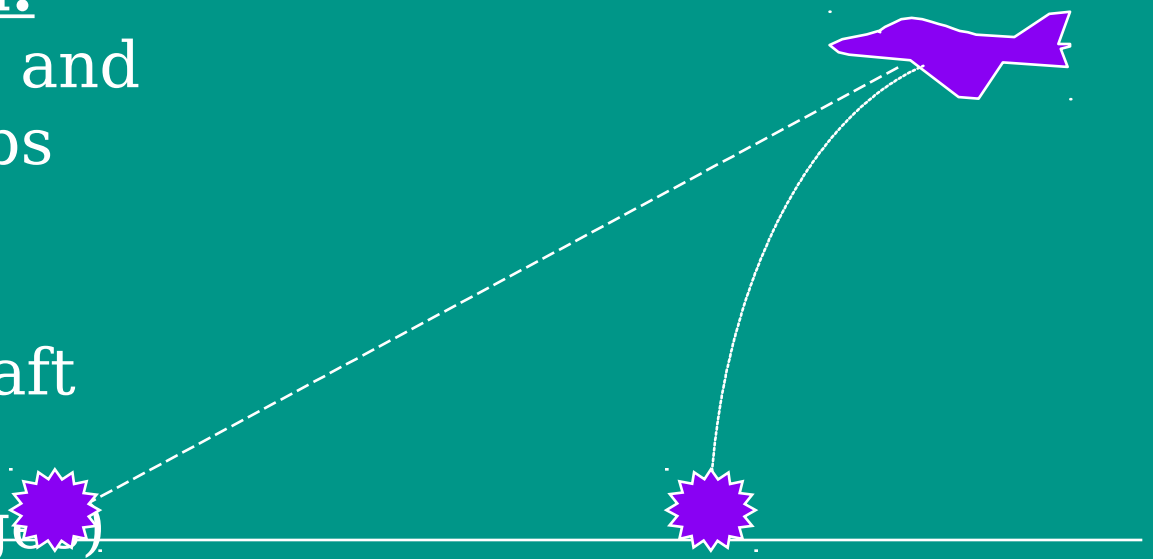
- Propulsion Types can be divided into two categories:
  - 1) Energy Source
    - Effect of Gravity
    - Compression of Liquids/Gasses
    - Chemical Reaction
  - 2) Method of Launch
    - Gravity - a bomb
    - Impulse - a projectile
    - Reaction - a missile

Gravity Propulsion

Simple: Uses the pull of gravity to get the weapon to the target.

Used in:

- All free fall and glide bombs
- Torpedoes launched from aircraft (until it submerges)



Impulse Launching Chemical Reaction

Impulse Propulsion

- Projectile is ejected from a container by means of an initial impulse.

- Explosive Propellant Train:

1) Primer 2) Igniter 3) Propellant Powder

Impulse Propulsion

Propellants

- Smokeless Powders or Gunpowder's:
  - All are designed to produce large volumes of gases at a controlled rate.
  - Rate is based on the maximum pressure that can be withstood by the gun barrel, casing, etc.

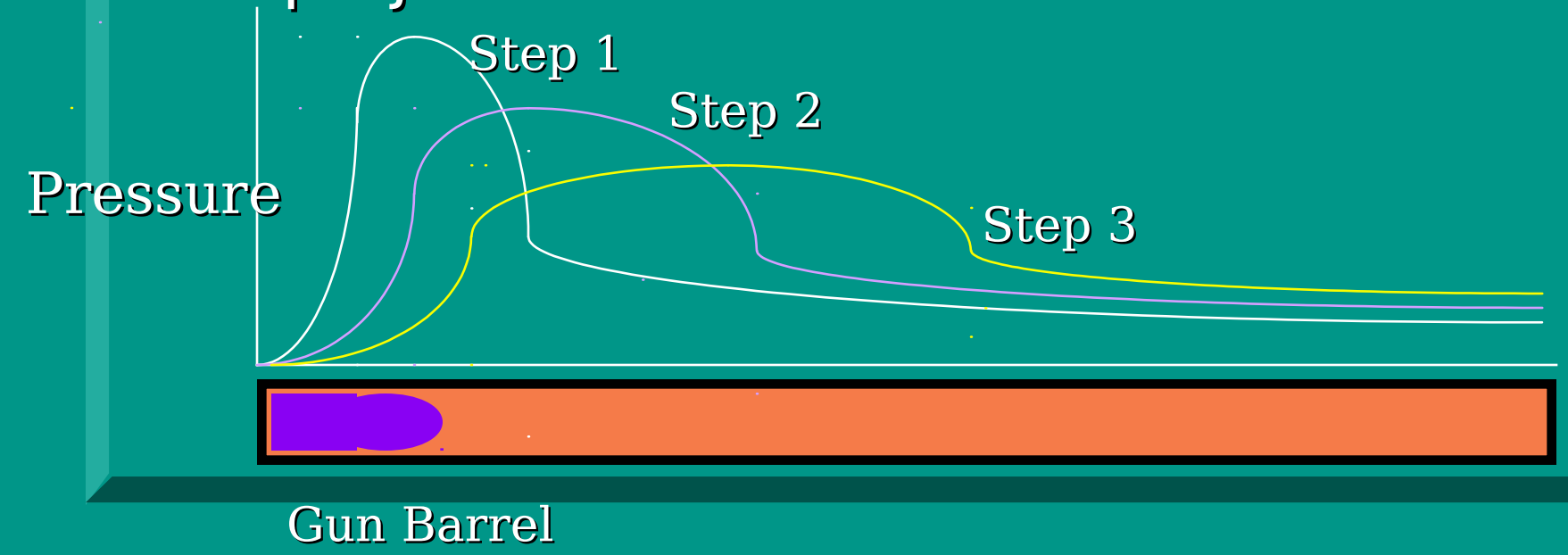
Burn Rate Controlling Factors

- controls the pressure generated by the propellant

- Size and shape of the powder grain
- Web thickness; amount of propellant between burning surfaces of the grain.
- Chemical burn rate constant of the propellant material
- Percentage of volatile material present.

Interior Ballistics

- Action Inside a Gun.
  - Ignited propellant creates pressure within the chamber that forces the projectile down the barrel.



Reaction Launch Compression of Liquids/Gasses

Propellants

- Compressed Air / Gas:
  - Used to eject missiles or torpedoes from submarines.
  - Easily controllable; doesn't harm weapons
  - *Problem:* Compressor machinery to maintain a supply of compressed gas.

Liquid Fuels

- More powerful than solid fuels
- High volatility
- Can’t be stored for long periods

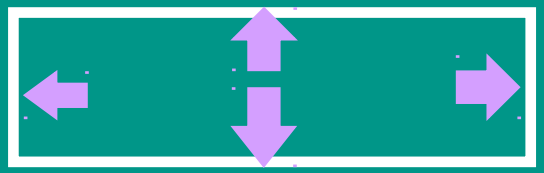
Reaction Propulsion

- Create a pressure differential in the medium they operate in, i.e. air or water.
- Examples include:
  - Rockets, Missiles
  - Cruise Missiles
  - Turbo-jet, and Ram Jet engines

Reaction Propulsion

- Development of Thrust in a Rocket Motor:

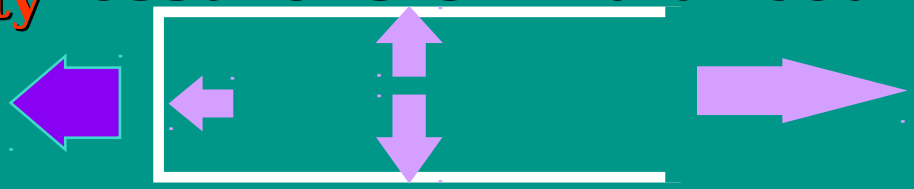
Pressure is Balanced



Burning Propellant along the in
of the casing exerts pressure in
directions at once, until a nozzl
fitted a one end.

Pressure is Un-Balanced

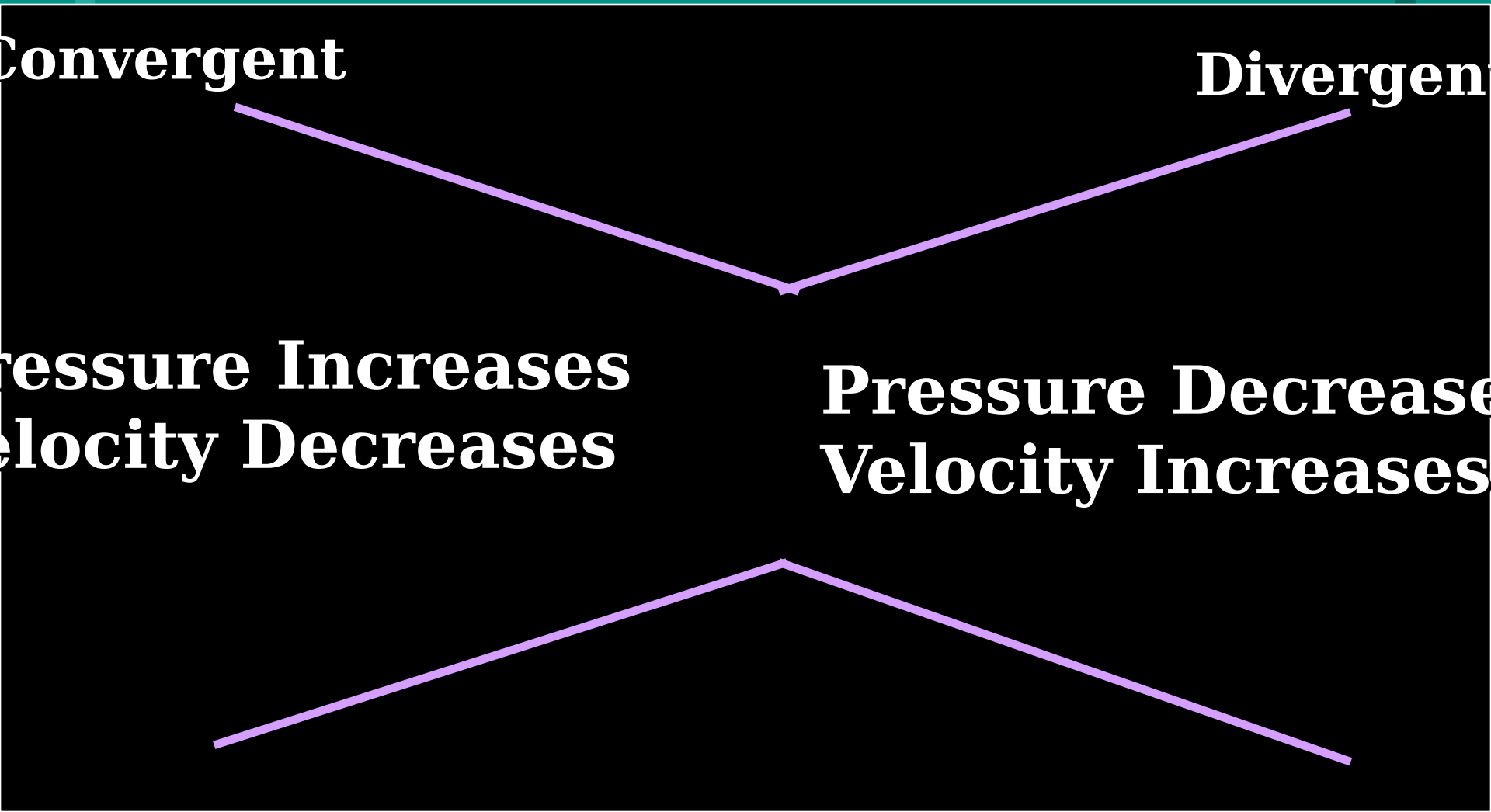
Forward Velocity



Thrust

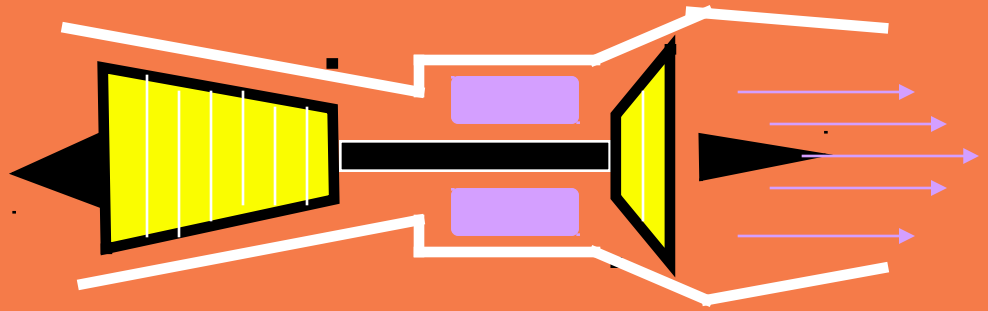
Reaction Propulsion

Bernoulli's Theory

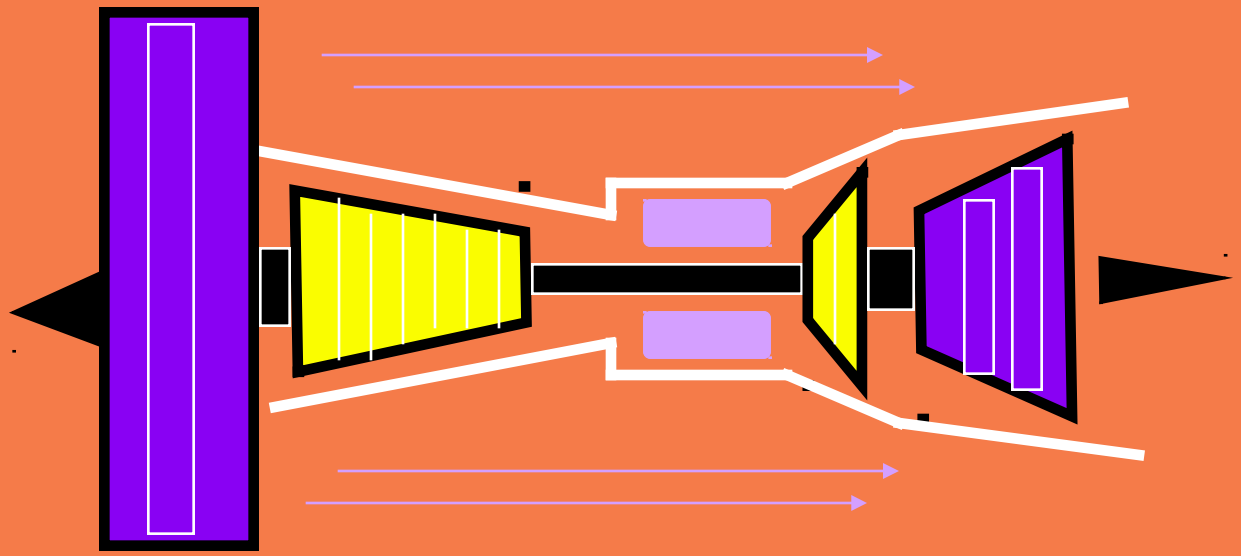


Turbojet

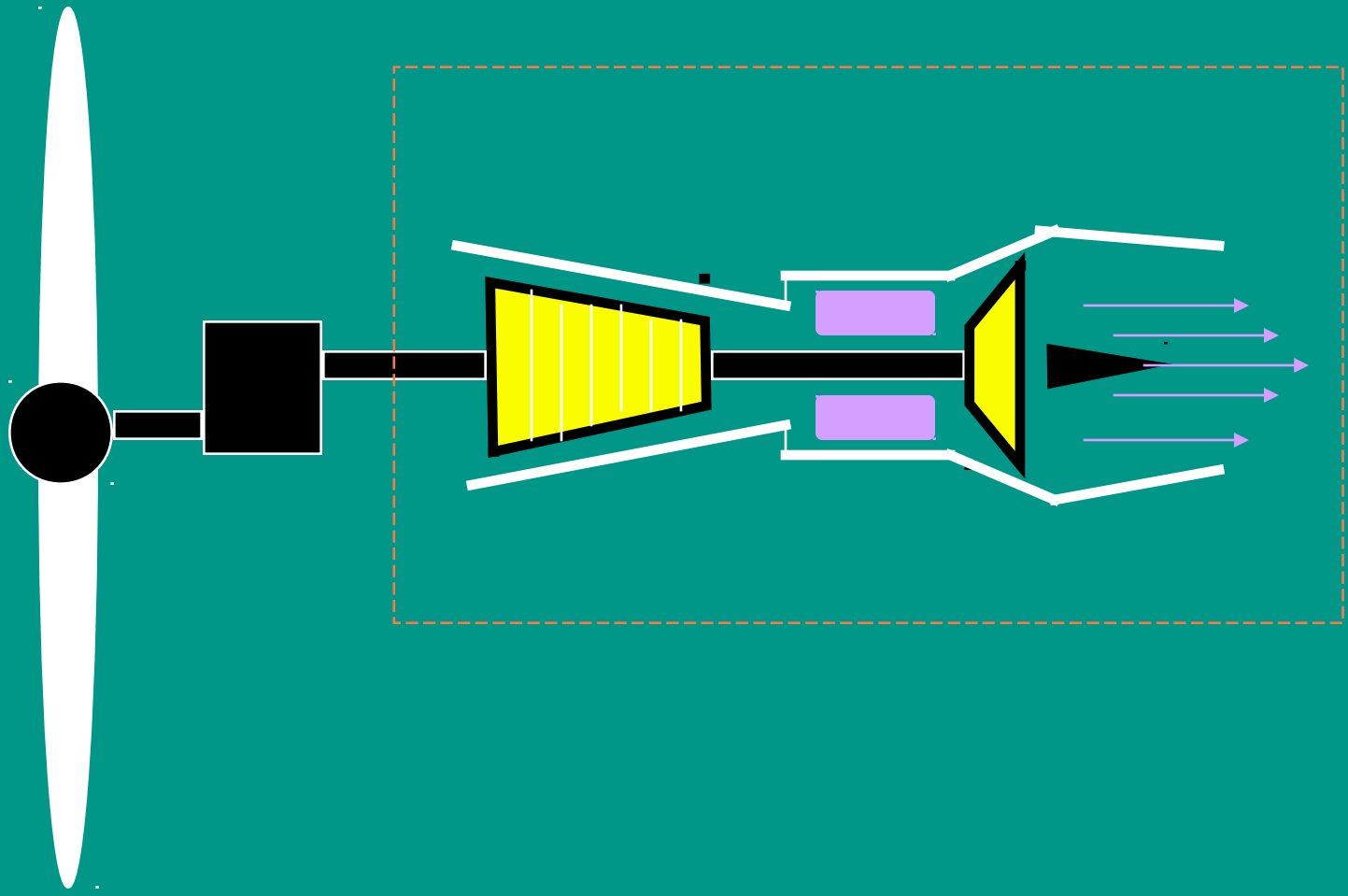
LM2500



DC 10

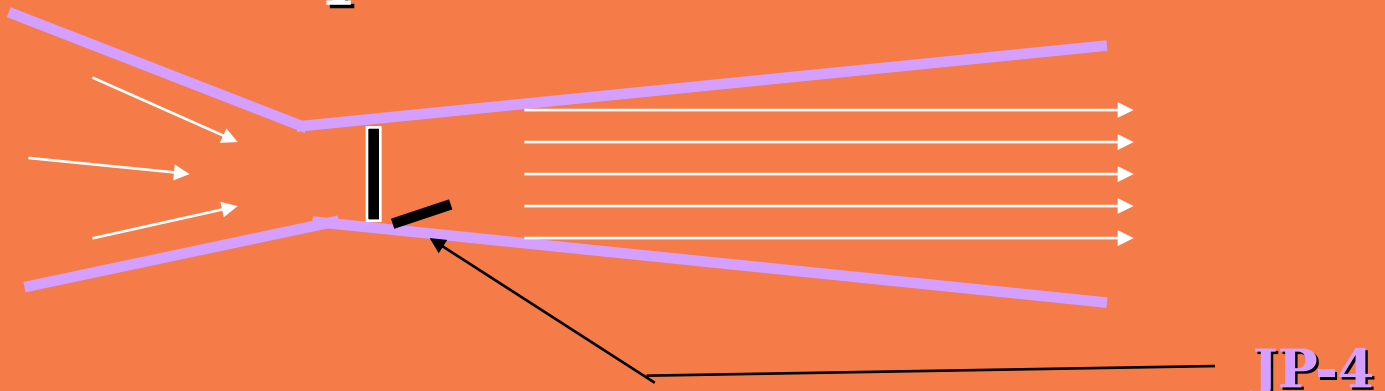


Turboprop

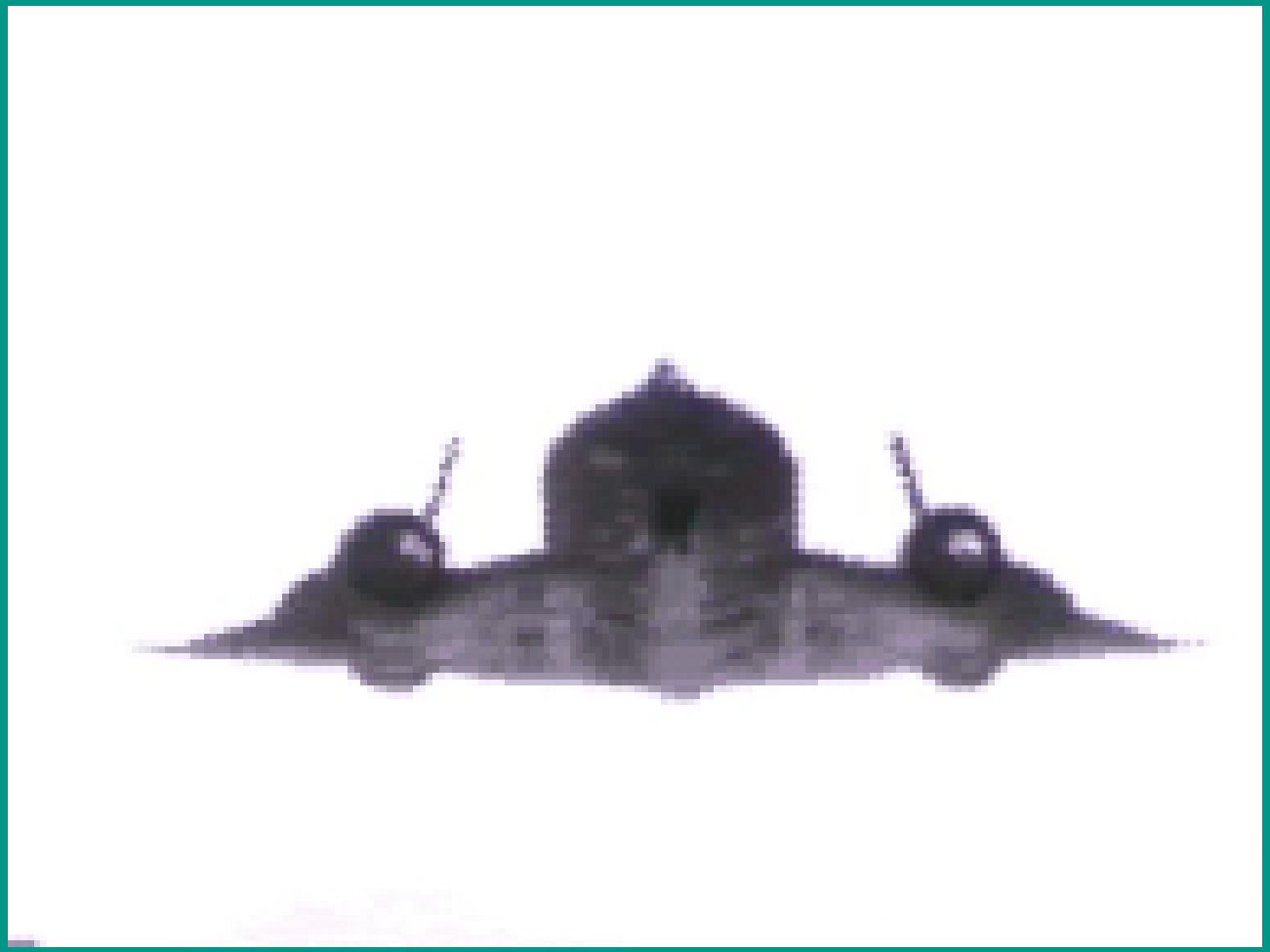


Ramjet

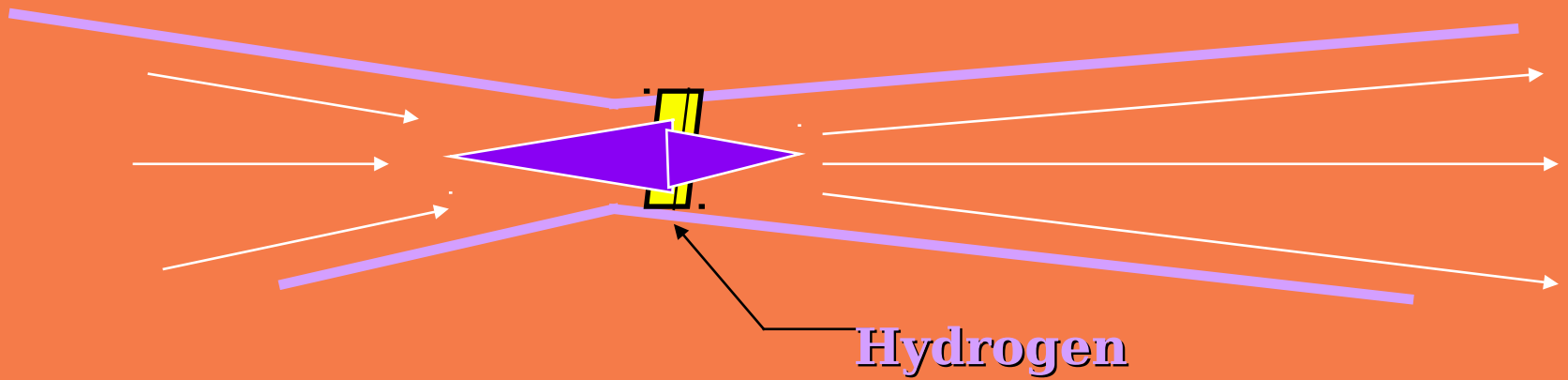
Low-Supersonic **Mach 3 to Mach 5**



SR-71 Blackbird



Scramjet



Hypersonic Mach 5 to Mach 20

Advantages / Disadvantages

- Solid Fuel
  - Simple
  - Unlimited Speed
  - Any medium/vacuum
  - No moving parts
  - Full thrust at takeoff
  - No booster
  - Store fully fueled
  - Ready to fire!

Advantages / Disadvantages

- Liquid Fuel
  - Simple
  - Practically unlimited speed
  - Any medium/vacuum
  - Few moving parts
  - Full thrust on take-off
  - Less need for booster than air breather
  - Staged with liquid/solid rockets

Advantages / Disadvantages

- Turbojet
  - Large static thrust
  - Oxygen from air
  - Common fuels
  - Thrust independent of speed

Advantages / Disadvantages

- Ramjet / Scramjet
  - Simple
  - No wearing parts
  - Oxygen from air
  - Lightweight
  - Inexpensive to build and operate
  - Common fuels
  - Efficient at high speeds/altitudes
  - Supersonic
  - Have to get it up to speed to work

Questions?